Nuclear energy: unsafe at any

This is the concluding installment of our look at nuclear energy.

by Jeff Moore

Ecology is about to engulf economics and politics in that how we run our lives will be increasingly determined by ecological imperatives.
William Ophuls
Author of *Ecology and the Politics of Scarcity*

Introduction

Part One of this feature was printed last October and in the interim I have continued to read arguments (both pro and con) in the nuclear debate. Although the two sides are at odds on most issues, they do agree on one point; that it is the duty of all of us to become informed and to participate in planning our energy future. To do this, we must acquaint ourselves with the nuclear power industry as it is one of our energy options. My own opinion is that it is the wrong option partly because I believe it will do irreparable damage to global ecosystems, and partly because I believe it will lead to a more paramilitarized, authoritarian and technocratic society.

These beliefs are intimately related to the two subjects dealt with in this article: the management of nuclear wastes and the link between the world-wide escalation of nuclear power plants and the proliferation of atomic weapons.

Waste Management

It is well-known by now that nuclear reactors produce radioactive wastes. But how do they produce such wastes? What volume of wastes do they produce? Where will these wastes be stored? Are these storage facilities safe? These are important questions that demand answers.

Nuclear waste is produced because as uranium fuel fissions and produces energy in the reactor, it also produces "fission products." These products "poison" the fuel and slow down the reaction. For this reason, "spent fuel" must be removed periodically from the reactor and replaced with fresh fuel. In a CANDU reactor this refuelling takes place every day.

The "spent fuel" bundles contain a mixture of highly radioactive isotopes with different half-lives (see Table 1). A half-life is the time required for one-half of the material originally present to undergo radioactive decay; at least ten half-lives are necessary for a radioactive substance to decay to a harmless one. For example, since plutonium-239 has a half-life of 24,300 years, it will require nearly one quarter of a million years to decay to a benign substance.

Plutonium-239 is one of the transuranics. These are isotopes with an atomic number higher than uranium due to the absorption of neutrons during the fission process. Because some of these radioactive isotopes decay to other substances with even longer half-lives, the ten half-lives rule does not always apply. The result is that nuclear waste remains toxic for an extremely long period of time. (See Figure 1.)

Spent fuel is called "high level waste" and must be stored so that it will not enter food chains and contaminate living substances. High level waste can cause both cancer and genetic defects in humans.

"Low level wastes" are substances that are irradiated in the reactor and include papers, plastic, mops, rags, and protective clothing. In Canada, these wastes are wrapped in plastic, placed in steel containers, and then shipped to the Bruce nuclear station where they are stored in steel reinforced concrete structures.

The main hazard to the environment remains high level wastes because they are intensely radioactive for decades, and remain radioactive for hundreds of thousands of years. Even if reprocessing becomes economically feasible, high level wastes will still have to be dealt with.

Reprocessing involves separating the fissile uranium and plutonium from the spent fuel and then mixing it with fresh reactor fuel. Currently, it is still cheaper to burn natural or enriched uranium in a single cycle than to reprocess fuel but as energy costs rise and uranium supplies deplete, reprocessing will become necessary.

In any event, high level wastes must be disposed of and to date no proven sale method for the storage of these wastes has been demonstrated. However, nuclear proponents are confident that deep geological storage is a safe method and it is the final phase in Ontario Hydro's four-stage Waste Management Proposal.

Stage one is the short-term storage phase. Spent fuel bundles are stored at the reactor site in steel-lined, concrete-reinforced, water-filled pools. The water provides shielding and circulates to dissipate the intense heat. The spent fuel remains here for five to fifty years. The Pickering A reactor in Ontario has aleady had to be modified to handle an additional ten station years of spent fuel. If the Pickering Station operates at full capacity, it will discharge about 12,000 bundles (around 275,000 kg.) per year.

During the second phase, the waste will be transported to a central interim storage facility and placed in air- or water-cooled concrete vaults. It will remain here for another fifty to one hundred years. Here also, the decision whether to permanently dispose of the bundles or to reprocess them will be made.

Phase three will involve the mixing of the wastes with glass-making materials, then placing the mixture in a crucible and heating it to an extremely high temperature. The result of this process will be a solid block matrix of glass and waste.

The final phase involves the transportation of these blocks to a deep geological waste storage site. Here they will be transported underground and then the hole will be sealed and back-filled. (See Figure 2.)

The possibility of wastes leaking at the final deep burial site remains a contentious issue. Nuclear energy proponents tout the geological disposal method as failsafe while opponents argue that such claims are irresponsible. A look at the past record of the overconfidence of atomic power scientists may once again be of value.

In 1971, Dr. Alvin Weinberg, then Director of the Oak Ridge National Laboratory, announced plans to dispose of high level radioactive wastes in abandoned salt mines in Kansas. He called the plan "one of the most far-reaching decisions any technologists have ever made, since the wastes can be dangerous for up to a million years." Within two months the project was scrapped because it was found to be clearly unsafe. Unsafe, despite the claims, and despite the expenditure of over one hundred million dollars in research money, and fifteen years of study.

Our own Canadian plans show a predisposition to using "plutons" as the final resting place for spent fuel. Plutons are geologically stable formations under the Canadian Shield. Proponents claim that these have no fissures and strain and will not allow the seepage of water. An added bonus is that they have little mineral value.

There is no proven safe method for the storage of high level wastes

What are the hazards involved in such a proposal? As with the transportation of any toxic substance, there is the danger of accidental leakage. This leakage can take place at any of the three depositories, and the past records of the U.S. nuclear industry are not impressive.

In 1977, the Fort Foundation sponsored a "nuclear energy policy study group" under the direction of the Mitre Corporation. This is what the group had to say about the high level waste storage facility — the Hanford Reservation — at Richland, Washington:

> *Experience with the storage of high level liquid waste has not been encouraging. From 1958 to 1974, eighteen leaks, totalling 429,400 gallons, were detected at Richland. In 1973, a leak involving the loss of 115,000 gallons went 48 days before being notices.*

Has the record of this disposal site improved since that time? According to a report in the New York Times on January 29th of this year, it is difficult to tell. David Burnham reported the following:

> *The Inspector General of the Energy Department has concluded that management policies at the nation's largest radioactive waste dump have worked "to keep publicity about possible leaks to a minimum. . ." In a formal statement to the Inspector General, Mr. Stalos (an environmental physicist at the reservation) said that when he tried to report one of these leaks, he was told by an Energy Department official that it was the Department's policy "that there will be no more leaks" because the announcement of them would hurt the nuclear industry.*

In this same news item, the inspectors were said to have reported that some important practices at the reservation "are in need of wholesale overhaul."

The record hardly inspires much confidence in the nuclear industry and although the Canadian record is much better, leakage of high level wastes remains a serious problem.

It is also possible for leakages to occur when the wastes are being transported between storage dumps. Although the casks undergo tough durability tests (including being dropped from thirty feet, being exposed to fire, and being submerged in water), certain accidents could damage the container enough to cause leakage.

These claims are based on scientific predictions. However, when trying to predict a million years into the future, a significant measure of speculation is involved. Other scientists are less confident than those in the industry and as a result an Ontario Royal Commission into electric power planning concluded that "at present we possess inadequate knowledge to ensure the integrity of the rock at comparatively high temperatures generated by the radioactive waste materials, or under pressure from deep drilling and construction of the depository itself."

The Canadian Coalition for Nuclear Responsibility also asserts that the proponents have neglected much in their claims about the insolubility of wastes vitrified in glass. The CCNR states that "AECL (Atomic Energy of Canada Ltd.) assumes that seventeen years of wet storage gives a good indication of the long-term stability of the glasses used for high level waste storage. This ignores the gradual build-up of helium gas inside the glass blocks; thermal stresses which will be more severe with dry storage than with set storage; possible devitrification of the glass as a result of long-term radiation damage to the crypto-crystalline structure; chemical reactions which could occur between the glass the granite enclosure; and fracturing of the glass blocks themselves."

Despite all the unanswered questions about high level waste storage, Canadian CANDU s continue to add more spent fuel to their storage ponds every day. What future generations will have to say about such short-sightedness will undoubtedly come under that euphemistic category made famous in the seventies — "expletive deleted."

Yet there are still individuals with less myopic vision involved in the Ontario Royal Commission quoted above. They recommend that if a panel of independent experts is not satisfied with spent fuel disposal research by 1985, a moratorium on nuclear construction might be justified.

The Power Reactor — Nuclear Weapons Link

In 1973 Argentina purchased a CANDU reactor from Canada. Argentina has decided to build a second German-made reactor and is also reported to be building a plutonium reprocessing plant with South African

SOME OF THE ISOTOPES PRESENT IN SPENT FUEL

Element	Symbol	Time to Decay to Half-Strength	Biological Implication
Tritium	$_{3}H$	12 years	Absorbed internally, it emits beta rays.
Krypton	$_{85}Kr$	4.4 hours	An inert gas, it radiates beta rays.
Strontium	$_{89}Sr$ $_{90}Sr$	53 days 28 years	Easily absorbed into the bones and lungs, it is retained and emits beta rays.
Iodine	$_{131}I$	8 days	Absorbed into the thyroid where it emits beta rays.
Xenon	$_{133}Xe$	5 days	An inert radioactive gas.
Cesium	$_{137}Ce$	30 years	Absorbed internally where it irradiates the body.
Uranium	$_{237}U$ $_{239}U$	2 days 23 minutes	Radioactive substance that can also be absorbed internally.
Plutonium	$_{238}Pu$ $_{239}Pu$ $_{240}Pu$ $_{241}Pu$ $_{242}Pu$ $_{243}Pu$	86 years 24,300 years 6,580 years 13 years 379,000 years 5 years	A considerable hazard to health, absorbed into the body organs.

TABLE 1.
Source: The Nuclear Book by David Peat